



UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/091,108	03/05/2002	Scott Lee Wellington	TH-1759X (US)	5886
23632	7590	07/27/2007	EXAMINER	
SHELL OIL COMPANY			LEUNG, JENNIFER A	
P O BOX 2463			ART UNIT	
HOUSTON, TX 772522463			PAPER NUMBER	
			1764	
			MAIL DATE	
			DELIVERY MODE	
			07/27/2007	
			PAPER	

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary

Application No.

10/091,108

Applicant(s)

WELLINGTON ET AL.

Examiner

Jennifer A. Leung

Art Unit

1764

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 21 May 2007.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1,2,4-8,10-28,32-35 and 40-45 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1,2,4-8,10-28,32-35 and 40-45 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
- ☐ Certified copies of the priority documents have been received.
 - ☐ Certified copies of the priority documents have been received in Application No. _____.
 - ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Jennifer A. Leung
7/23/07

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO/SB/08)
Paper No(s)/Mail Date _____
- 4) ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____
- 5) ☐ Notice of Informal Patent Application
- 6) ☐ Other: _____

DETAILED ACTION

Continued Examination Under 37 CFR 1.114

1. A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on May 21, 2007 has been entered.

Response to Amendment

2. Applicant's amendment submitted on May 21, 2007 has been carefully considered. Claims 3, 9, 29-31, 36-39 and 46 are cancelled. Claims 1, 2, 4-8, 10-28, 32-35 and 40-45 are under consideration.

Information Disclosure Statement

3. The information disclosure statement (IDS) filed on October 16, 2002 fails to comply with 37 CFR 1.98(a)(2) because a copy of the cited "Search Report dated 10/09/02" has not been provided. The IDS has been placed in the application file, but the cited search report has not been considered.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the

Art Unit: 1764

claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

4. Claims 1, 2, 4-8, 10-15, 17, 19-21, 25, 32-35, 40-43 and 45 are rejected under 35 U.S.C. 103(a) as being unpatentable over Minet et al. (US 5,229,102) in view of Mikus et al. (WO 99/18392), Topsoe (US 5,169,717) and Imai et al. (JP 04-321502).

Regarding claims 1, Minet et al. (FIG. 1; column 3, line 55 to column 5, line 6) discloses an apparatus comprising:

a steam reforming reactor **10** comprising two concentric sections including a larger outside section (i.e., containing burners **14**) and a smaller inside section (i.e., interior **11a**, defined by membrane tube **11**) and an annulus containing reforming catalyst between said sections (i.e., annulus **16** containing reforming catalyst **17**);

said annulus section **16** having an inlet for steam and vaporizable hydrocarbon (i.e., via connection **15**), a flow path for hydrogen and by-product gases in said annulus section **16**, and an outlet for said by-product gases (i.e., via point **D**);

said outside section being in heat transferring contact with said annulus section **16** (i.e., via heat transfer through metallic tube **13**), and having a heating means comprising inlets for fuel gas and combustion air in communication with a plurality of vertically spaced burners **14** for distributing radiant heat to said annulus section **16** via the tube **13**; and

said inside section **11a** having a hydrogen-selective, hydrogen-permeable membrane (i.e.,

Art Unit: 1764

located on catalytic ceramic membrane tube **11**) positioned either on the inside or outside of said inside section **11a**, and an outlet for hydrogen (i.e., via pipe connection **12a**) which permeates through said membrane **11** from said annulus section **16** into said inside section **11a** and passes through said outlet **12a**.

Minet et al. is silent as to whether the heating means may instead comprise an inlet for preheated air or other oxidant and a plurality of tubes for fuel gas, said tubes having openings through which the fuel gas flows and is mixed with said air or other oxidant resulting in flameless distributed combustion. In contrast, the combustion disclosed by Minet et al. is not flameless, as evidenced by the flames generated by burners **14**.

Mikus et al. (FIG. 1, 3; page 8, line 3 to page 10, line 15; page 10, line 25 to page 11, line 3) teaches a heating means comprising an inlet for preheated air or other oxidant (i.e., inlet **2**) and a plurality of tubes for fuel gas (i.e., fuel conduit **5**, shown in plurality in FIG. 3), said tubes having openings through which the fuel gas flows (i.e., fuel nozzles **6**) and is mixed with said air or other oxidant (i.e., within the oxidation reaction chamber **1**) resulting in "flameless distributed combustion," (specifically, page 8, lines 10-17) whereby uniform tailored, controlled heat is transferred to an adjacent process chamber **8**. The process chamber **8** may comprise a catalytic steam reformer (page 13, lines 17-25; page 16, line 34 to page 17, line 30). It would have been obvious for one of ordinary skill in the art at the time the invention was made to substitute the heating means of Mikus et al. for the heating means in the apparatus of Minet et al., on the basis of suitability for the intended use, because the "flameless distributed combustion" provides a controllable heat flux into a process chamber, from a heat source which has a uniform temperature, and a very low creation of NO_x, as taught by Mikus et al. (page 5, lines 1-7).

In view of the newly added limitation, Minet et al. is silent as to the provision of a fuel cell in direct communication with the outlet for hydrogen from the steam reforming reactor **10**.

In any event, it would have been obvious for one of ordinary skill in the art at the time the invention was made to provide a fuel cell in direct communication with the outlet for the hydrogen from the steam reforming reactor **10** in the modified apparatus of Minet et al., on the basis of suitability for the intended use and absent a showing of unexpected results thereof, because a well known end use for the hydrogen produced by steam reforming reactors is as a fuel for the generation of electricity in fuel cells, and when a patent simply arranges old elements with each performing the same function it had been known to perform and yields no more than one would expect from such an arrangement, the combination is considered obvious. In addition, the art is replete with examples in which the hydrogen produced by a steam-reforming reactor is fed directly to a fuel cell for the generation of electricity, such as evidenced by Topsoe and Imai et al. In particular, Topsoe teaches a conventional steam reforming reactor – fuel cell combination, in which a steam reforming reactor **3** produces hydrogen for direct supply to the anode **1A** of a fuel cell (see FIG. 1). Imai et al. further teaches a conventional steam reforming reactor – fuel cell combination, in which a steam reforming reactor comprising a larger outside section (i.e., defined between reaction tube **1** and outer tube **2**), a smaller inside section (i.e., defined by hydrogen membrane **3**) and an annulus section containing reforming catalyst **4**, produces hydrogen that permeates through the membrane **3** from the annulus section to an outlet, for direct supply to a fuel cell **12** via line **7** (see FIGs. 1, 2 and Abstract). Thus, the claimed steam reforming reactor – fuel cell combination is no cause for patentability here.

Regarding claims 2 and 43, Minet et al. further discloses an inlet adapted to convey a

Art Unit: 1764

sweep gas comprising steam (i.e., H₂O steam supplied to the interior **11a** of the membrane tube **11** via connection **12** at point **B**; FIG. 1; column 4, lines 17-25).

Regarding claims 4 and 5, Minet et al. discloses the reforming catalyst **17** comprises at least one Group VIII transition metal; in particular, nickel metal (column 3, lines 67-68).

Regarding claims 6-8, 10 and 11, Minet et al. further discloses that typical reforming catalysts comprise nickel deposited on a support comprising oxides of Group IIIA; in particular, alumina support materials (column 1, lines 19-41). It would have been obvious for one of ordinary skill in the art at the time the invention was made to select the typical reforming catalyst for the reforming catalyst **17** in the apparatus of Minet et al., because the use of such catalysts is well known in the art of steam reforming, as evidenced by Minet et al.

Regarding claim 12, Minet et al. discloses the hydrogen-permeable selective membrane (i.e., on catalytic ceramic membrane tube **11**; FIG. 1) comprises one or more Group VIII transition metals or alloys; in particular, nickel (column 4, lines 3-25; column 6, lines 9-17).

Regarding claims 13-15 and 17, Minet et al. discloses the hydrogen permeable membrane (i.e., on catalytic ceramic membrane tube **11**; FIG. 1; column 4, lines 3-25) being situated on a porous ceramic support comprising oxides of Group IIA; in particular, alumina (i.e., the nickel or other suitable catalytic material as well as Layer 1, Layer 2 and Layer 3 being situated on a support of alpha alumina; see TABLE 2).

Regarding claims 19-21, Minet et al. discloses said membrane support (i.e., a Support of alpha alumina; see Table 2; column 4, lines 3-25) provides an intermediate layer (i.e., Layer 1, or Layer 2, or Layer 3; see Table 2) between the membrane and the catalyst **17**. The support of alumina inherently limits heat transfer to the membrane, as defined by applicant in section

Art Unit: 1764

[0048] of the specification.

Regarding claim 25, Minet et al. discloses the membrane has a thickness in the range of 10 Angstroms to 150 μm (i.e., see Table 2, column 4, lines 3-25, wherein the sum of Layer 1, Layer 2, and Layer 3 is about 85 microns in thickness).

Regarding claims 32 and 33, Topsoe further teaches that a suitable fuel cell comprises a high pressure molten carbonate fuel cell (i.e., a Molten Carbon Fuel Cell, MCFC, operating at pressures up to 120 psia, or an Integral Reforming Molten Carbonate Cell, IRMCFC, operating at pressures up to 120 psia; see Table 1; see column 1, line 57 to column 2, line 66), such types of fuel cells being well known in the art.

Regarding claim 34, Minet et al. is silent as to the steam reformer **10** being “scalable and easily adjustable to any size fuel cell.” In any event, it would have been obvious for one of ordinary skill in the art at the time the invention was made to configure the steam reformer to be scalable and easily adjustable to any size fuel cell in the modified apparatus of Minet et al., on the basis of suitability for the intended use, because it has been held that changes in size involve only ordinary skill in the art. *In re Rose*, 220 F.2d 459, 463, 105 USPQ 237, 240 (CCPA 1955).

Regarding claim 35, Minet et al. is silent as to the steam reformer **10** being mobile. In any event, it would have been obvious for one of ordinary skill in the art at the time the invention was made to configure the steam reformer to be mobile in the modified apparatus of Minet et al., on the basis of suitability for the intended use, because making an apparatus portable was held to have been obvious, *In re Lindberg* 93 USPQ 23 (CCPA 1952).

Regarding claims 40-42, Minet et al. further discloses the steam reformer tube **13** being constructed from high alloy material, such as SS304, SS310, SS316, or the like (column 3, line

68 to column 4, line 2). For instance, the material SS304, a.k.a. AISI 304 stainless steel, comprises about 18% Cr and about 8% Ni, with the balance comprising iron.

Regarding claim 45, as best understood, the modified apparatus of Minet et al. structurally meets the claim because the modified apparatus includes all of the claimed structural elements. The recitation that an element is "adapted to" perform a function is not a positive limitation but only requires the ability to so perform. It does not constitute a limitation in any patentable sense. *In re Hutchison*, 69 USPQ 138.

5. Claims 16, 18, 22 and 25-28 are rejected under 35 U.S.C. 103(a) as being unpatentable over Minet et al. (US 5,229,102) in view of Mikus et al. (WO 99/18392), Topsoe (US 5,169,717) and Imai et al. (JP 04-321502), as applied to claims 1, 12, 13 and 15, and further in view of Lin et al. (EP 1 024 111).

Regarding claim 16, 18 and 22, Minet et al. is silent as to the whether the hydrogen-permeable membrane **11** may instead comprise a support of porous metal, and/or a membrane selected from palladium and palladium alloys. Lin et al. (FIG. 1) teaches a hydrogen-permeable membrane (i.e., on hydrogen-permeable membrane tube **14**) located within a steam reforming section containing reforming catalyst **13**, wherein the hydrogen-permeable membrane includes a porous substrate selected from porous stainless steel or porous ceramic material, and a membrane comprising a thin metal layer of palladium or a palladium alloy (see section [0012]). It would have been obvious for one of ordinary skill in the art at the time the invention was made to substitute the hydrogen-permeable membrane of Lin et al. for the hydrogen-permeable membrane **11** in the modified apparatus of Minet et al., on the basis of suitability for the intended use thereof, because the hydrogen-permeable membrane of Lin et al. provides a high hydrogen

Art Unit: 1764

permeation flux that allows both the reforming temperature and the transmembrane pressure different to be reduced to a lower level. The reduced temperature and transmembrane pressure difference can provide the benefits of using less expensive material for the entire reactor, saving heat energy, and reducing undesirable effects on the mechanical strength and stability of the hydrogen-permeable membrane, as taught by Lin et al. (see section [0015]). In any event, the substitution of known equivalent structures involves only ordinary skill in the art. *In re Fout* 213 USPQ 532 (CCPA 1982); *In re Susi* 169 USPQ 423 (CCPA 1971); *In re Siebentritt* 152 USPQ 618 (CCPA 1967); *In re Ruff* 118 USPQ 343 (CCPA 1958).

Regarding claims 25-27, Lin et al. further teaches that the hydrogen-permeable membrane (i.e., the thin metal layer) has a thickness of 1 to 20 μm (section [0012]), which lies within the claimed range.

Regarding claim 28, Lin et al. further teaches that the hydrogen-permeable membrane has a measured permeability of hydrogen in the range of 3-10 $\text{m}^3/\text{m}^2\text{-h-atm}^{0.5}$ (section [0019]), which lies within the claimed range.

6. Claim 23 is rejected under 35 U.S.C. 103(a) as being unpatentable over Minet et al. (US 5,229,102) in view of Mikus et al. (WO 99/18392), Topsoe (US 5,169,717), Imai et al. (JP 04-321502) and Lin et al. (EP 1 024 111), as applied to claims 1, 12 and 22 above, and further in view of Juda et al. (US 5,904,754) or Rosset (US 2,958,391) or Behr et al. (US 4,496,373).

The combined teachings of Minet et al., Mikus et al., Topsoe, Imai et al. and Lin et al. are silent as to the hydrogen-permeable membrane comprising at least one of the instantly claimed Pd alloys. In any event, it would have been obvious for one of ordinary skill in the art at the time the invention was made to substitute at least one of the instantly claimed alloys for the hydrogen-

Art Unit: 1764

permeable membrane in the modified apparatus of Minet et al., on the basis of suitability for the intended use thereof, because the substitution of known equivalent structures for providing the same function of hydrogen permeation would involve only ordinary skill in the art. *In re Fout* 213 USPQ 532 (CCPA 1982); *In re Susi* 169 USPQ 423 (CCPA 1971); *In re Siebentritt* 152 USPQ 618 (CCPA 1967); *In re Ruff* 118 USPQ 343 (CCPA 1958). Juda et al. (column 3, line 1 to column 4, line 49) teaches a known hydrogen-permeable membrane comprising an alloy of Pd with 40% copper for use as a wall connecting high and low pressure chambers of a hydrogen generator. Rosset (column 2, lines 16-44) teaches another known hydrogen-permeable membrane comprising an alloy of Pd with small amounts up to about 60% silver, or preferably from about 25 to about 40 atom percent silver. Behr et al. (column 1, line 42 to column 2, line 8) teaches yet another known hydrogen-permeable membrane comprising an alloy of Pd with at least 7 % Y, or at least 45 % Cu.

7. Claim 24 is rejected under 35 U.S.C. 103(a) as being unpatentable over Minet et al. (US 5,229,102) in view of Mikus et al. (WO 99/18392), Topsoe (US 5,169,717) and Imai et al. (JP 04-321502), as applied to claims 1 and 12 above, and further in view of Rosset (US 2,958,391).

The combined teachings of Minet et al., Mikus et al., Topsoe and Imai et al. are silent as to the hydrogen-permeable membrane being selected from platinum or platinum alloys. In any event, it would have been obvious for one of ordinary skill in the art at the time the invention was made to substitute a membrane selected from platinum or platinum alloys for the hydrogen-permeable membrane in the modified apparatus of Minet et al., on the basis of suitability for the intended use thereof, because the substitution of known equivalent structures for providing the same function of hydrogen permeation would involve only ordinary skill in the art. *In re Fout*

213 USPQ 532 (CCPA 1982); *In re Susi* 169 USPQ 423 (CCPA 1971); *In re Siebentritt* 152 USPQ 618 (CCPA 1967); *In re Ruff* 118 USPQ 343 (CCPA 1958). Rosset teaches that hydrogen-permeable membranes comprising platinum or platinum alloys are well known in the art. In particular, platinum may be employed to improve the permeability of the membrane to hydrogen without sacrificing purity of the gaseous product or without weakening the structural properties of the membrane (column 2, lines 31-39).

8. Claim 44 is rejected under 35 U.S.C. 103(a) as being unpatentable over Minet et al. (US 5,229,102) in view of Mikus et al. (WO 99/18392), Topsoe (US 5,169,717) and Imai et al. (JP 04-321502), as applied to claim 1 above, and further in view of Edlund (US 5,861,137).

Minet et al. is silent as to the apparatus further comprising a methanation catalyst packed within said inside section **11a**. Edlund (FIG. 3; column 5, lines 9-40) teaches a steam reforming reactor **12** including an annulus (i.e., annular reforming region **62**) containing reforming catalyst **102** and an inside section defined by a hydrogen-selective, hydrogen-permeable membrane (i.e., membrane tube **54**) positioned on the outside of said section; the apparatus further comprising a methanation catalyst (i.e., polishing catalyst **110**) packed within said inside section to react with any trace amounts of CO present in the hydrogen **103** which permeates through said membrane **54**. It would have been obvious for one of ordinary skill in the art at the time the invention was made to provide a methanation catalyst within the inside section **11a** in the modified apparatus of Minet et al., on the basis of suitability for the intended use, because the methanation catalyst converts carbon monoxide and carbon dioxide impurities that remain in the hydrogen stream into methane, which is considered relatively inert or innocuous to fuel cells, whereas carbon dioxide and carbon monoxide are poisonous to fuel cells, as taught by Edlund (column 5, lines 27-40).

Response to Arguments

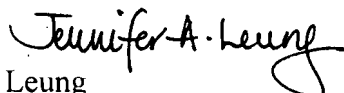
9. Applicant's arguments with respect to claims 1, 2, 4-8, 10-28, 32-35 and 40-45 have been considered but are moot in view of the new ground(s) of rejection, necessitated by amendment.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Jennifer A. Leung whose telephone number is (571) 272-1449. The examiner can normally be reached on 9:30 am - 5:30 pm Monday through Friday.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Glenn A. Caldarola can be reached on (571) 272-1444. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.


Jennifer A. Leung
July 23, 2007